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Dear Mike

Research in Nonlinear Water Waves  
Navy Grant No. N00014-89-J-1164

Quarterly letter progress report Jul 1, 1989 - Sep 30, 1989

Work has continued during the quarter on the effect of a thin wind drift layer on the structure of capillary gravity waves of permanent form. Results have been obtained for waves that are not too steep. This work is currently being prepared for publication. Further research is continuing in two directions.

First, we are studying the rather difficult question of the structure of the wind drift layer for steep waves. This involves construction of an integral equation approach, as the Fourier series method employed for the gentle waves becomes inadequate when the waves are steep. We have chosen a particular method, and the task now is to formulate the calculation method precisely, decide on the specific discretization to be employed, check that the counting is correct (this is a self consistency check on the formulation) and last but not least program the calculation efficiently and access good graphics.

Second is the study of the instability of the thin wind drift layer and the realization that the instability may be related to the generation of waves by wind in some physical circumstances. Satisfactory progress has been made with this work for the instability in the absence of waves or swell. The predictions are being used to study the development

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of an initially small wave spectrum. It is hoped to begin shortly to write this work up for publication. We are continuing with a study of the instability in the presence of swell. Two questions are of interest. First is the existence of steady waves of permanent form. This question has been answered for infinitesimal waves, and studies to answer the question are in progress for waves of finite amplitude. And second is a direct investigation of the instability of the wind drift layer on long waves.

In regard to our studies of Hamiltonian formulation of water wave dynamics, we are investigating the possibility of using 'symplectic integration' in order to obtain accurate integration of water wave evolution. This is a new method, developed in the last few years, based on the concept that the finite difference forms of the equations should be chosen so that they preserve the Hamiltonian symplectic structure. In other words, the differencing should satisfy the constraint that the variables at time  $t + \delta t$  are canonical transformations of the variables at time  $t$ . Trials of this method for simple oscillators show that symplectic integration preserves the qualitative structure of the oscillations and enables accurate integration to be carried out for much longer intervals than the usual methods.

With best wishes

Yours sincerely

*Philip*

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cc: Director, Naval Research Laboratory  
cc: Defense Technical Information Center

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